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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/020,314	12/18/2001	Yasuhiro Shimamoto	HITA.0143	8410
38327	7590	10/14/2004	EXAMINER	
REED SMITH LLP 3110 FAIRVIEW PARK DRIVE, SUITE 1400 FALLS CHURCH, VA 22042			NGUYEN, KHIEM D	
			ART UNIT	PAPER NUMBER
			2823	

DATE MAILED: 10/14/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/020,314

Applicant(s)

SHIMAMOTO ET AL.

Examiner

Khiem D Nguyen

Art Unit

2823

Am

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 August 2004.
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
4a) Of the above claim(s) _____ is/are withdrawn from consideration.
5) ☐ Claim(s) _____ is/are allowed.
6) ☒ Claim(s) 1-20 is/are rejected.
7) ☐ Claim(s) _____ is/are objected to.
8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
10) ☒ The drawing(s) filed on 18 December 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE
PRIMARY EXAMINER

10/14/2004

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____

- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on August 3rd, 2004 has been entered. A new rejection is made as set forth in this Office Action. Claims (1-20) are pending in the application.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

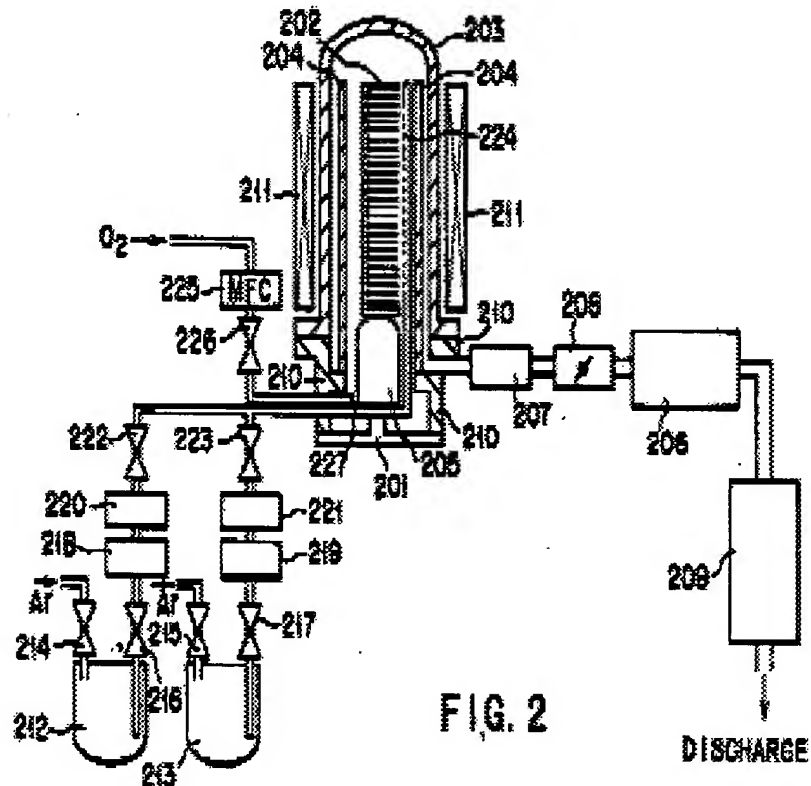
(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-3, 11 and 16-19 are rejected under 35 U.S.C. 102(e) as being anticipated by Eguchi et al. (U.S. Patent No. 6 297,122).

In re claim 1, Eguchi discloses a fabricating method of a semiconductor integrated circuit comprising forming a ruthenium electrode 103 of a capacitor with high-k material on a semiconductor substrate 101 by a chemical vapor deposition method in a sub-atmospheric pressure using an organoruthenium compound as a precursor (col. 4, line 65 to col. 5, line 3 and FIG. 1B), which includes:

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a first step of providing the semiconductor substrate 101 in a deposition chamber, increasing a temperature of the semiconductor substrate 101 in the chamber up to a desired temperature 550° C using heater 211 (col. 4, line 65 to col. 5, line 34 and FIG. 2);



a second step of separately supplying the precursor and an oxidation gas into the deposition chamber to form a ruthenium film 103 with a desired thickness on the heated semiconductor substrate (col. 5, lines 37-65), the oxidation gas being separately supplied to the deposition chamber by a supplying system 225 through valve 226 that is different from a precursor supplying system 212, 213 through valves 222, 223 (FIG. 2); and

a third step of stopping the supply of the precursor and the oxidation gas O₂ and decreasing the temperature of the semiconductor substrate (col. 5, line 66 to col. 6, line 16).

In re claim 2, Eguchi discloses wherein the ruthenium electrode is a top electrode and the supply of the oxidation gas into the deposition chamber being carried out through all the first, second, and third steps (col. 6, lines 5-16 and col. 12, lines 32-39).

In re claims 3 and 19, Eguchi discloses wherein the ruthenium electrode forming method further includes a step of introducing a balance gas in addition to a carrier gas (Ar) so as to keep a pressure in the deposition chamber constant through all of the other steps (col. 5, lines 41-47),

In re claim 11, Eguchi discloses that the solvent for dissolving the organoruthenium compound comprises tetrahydropuran (col. 5, lines 37-40).

In re claim 16, Eguchi discloses wherein the electrode of ruthenium of a capacitor with high-k material is formed on the semiconductor substrate, and immediately thereafter annealing is performed at not less than the formation temperature of the bottom electrode of ruthenium in an inert atmosphere or a reducing atmosphere thereby inhibiting deformation of crystal grains of the bottom electrode of ruthenium in the annealing step during or after capacitor insulator formation (annealing at 300° C) (col. 5, line 4 to col. 6, line 16).

In re claim 17, Eguchi discloses wherein the electrode is a bottom electrode (col. 11, line 65 to col. 12, line 39).

In re claim 18, Eguchi discloses wherein the oxidation gas comprises at least one of O₂, N₂O, H₂O, NO₂, and O₃ (col. 5, line 62 to col. 6, line 8).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 4-9, 10, 12-15 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eguchi et al. (U.S. Patent No. 6 297,122) in view of Won et al. (U.S. Pub. 2001/0006838) and Yang (U.S. Patent 6,617,248).

In re claims 4-9, Eguchi does not explicitly disclose that the amount of oxygen adsorption onto the surface of the semiconductor substrate is set to a minimum amount required for de-composing the precursor thereby increasing the amount of oxygen adsorption onto the surface of the semiconductor substrate and shortening a growth time of the electrode. However, the disclose process would obtain the recited results because the same materials are treated in the same manner as in the instant invention.

In re claim 10, Eguchi does not explicitly disclose wherein the organoruthenium compound comprises at least one of bis-(ethylcyclopentadienyl) ruthenium [Ru(C₂H₅C₅H₄)₂], bis-(methylcyclopentadienyl)ruthenium [Ru(CH₃C₅H₄)₂], bis-ethylcyclopentadienyl)ruthenium [Ru(C₂H₅C₅H₄)₂], tris-(dipivaloylmethanate)ruthenium (Ru(C₁₁H₁₉O₂)₃), and Ru

Won, however, discloses that the organoruthenium compound comprises bis-(ethylcyclopentadienyl) ruthenium $[\text{Ru}(\text{C}_2\text{H}_5\text{C}_5\text{H}_4)_2]$ (pages 2-3, paragraph [0029]). It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teaching of Eguchi and Won to enable the organoruthenium compound of Eguchi to be formed and furthermore Ru films having improved continuity and reduced sheet resistance may be obtained (page 2, paragraph [0013], Won et al.).

In re claim 12, Eguchi does not explicitly disclose performing annealing at not less than a formation temperature of the bottom electrode made of ruthenium metal film in a reducing atmosphere containing hydrogen thereby removing oxygen introduced into a surface of the ruthenium metal film when the ruthenium metal film is formed therefrom and inhibiting deformation of crystal grains of the bottom electrode made of ruthenium metal film in the annealing step during or after forming a high-k capacitor insulator.

Yang, however, discloses performing annealing at not less than a formation temperature of the electrode made of ruthenium metal film (at between about 400 to 800°C) in a reducing atmosphere containing hydrogen thereby removing oxygen introduced into a surface of the ruthenium metal film when the ruthenium metal film is formed therefrom (col. 2, line 60 to col. 3, line 58) and inherently inhibiting deformation of crystal grains of the electrode of ruthenium in the annealing step during or after capacitor insulator formation. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teaching of Eguchi and Yang to enable the process of annealing the bottom electrode of ruthenium in a reducing atmosphere

containing hydrogen of Eguchi to be performed and furthermore to obtain a ruthenium metal layer having various degrees of smooth and rough textures (Abstract, Yang).

In re claims 13 and 20, Eguchi discloses that the annealing temperature in the reducing atmosphere is not more than the annealing temperature for crystallization of the capacitor insulator (col. 5, lines 31-57).

In re claim 14, Eguchi discloses that the temperature at which the deformation of crystal grains of the bottom electrode of ruthenium is inhibited is 800 °C or less (col. 5, line 4 to col. 6, line 16).

In re claim 15, Eguchi does not explicitly disclose that an average grain size of the crystal grains of the bottom electrode of ruthenium is 30 nm to 60 nm. However, there is no evidence indicating that the average grain size of the crystal grains of the bottom electrode of ruthenium is critical and it has been held that it is not inventive to discover the optimum or workable size or thickness of a result-effective variable within given prior art conditions by routine experimentation. See MPEP § 2144.05. Note that the specification contains no disclosure of either the critical nature of the claimed dimensions of any unexpected results arising there from. Where patentability is aid to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Khiem D Nguyen whose telephone number is (571) 272-1865. The examiner can normally be reached on Monday-Friday (8:00 AM - 5:00 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (571) 272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

K.N.
October 13th, 2004

HSIEN-MING LEE
PRIMARY EXAMINER

10/14/2004